Electronic Version
Stylesheet Version v1.1.1

Description

Automatic Lockset Tamper Detection Device and Method

Cross Reference To Related Applications

[0001] This application is a continuation of my Provisional Patent Application Number 60/319,451 filed August 6th, 2002

Background of Invention

[0002] Home security systems are notoriously subject to both false alarms and missed alarms. Over 90% of home security alarms are reported to be false alarms. Missed alarms, from failure to turn the security system on, are estimated to occur 30% to 50% of the time. The principal failing of these systems is in the extra time and care required to disable security systems before entry and to enable them upon leaving.

[0003] Law provides more severe penalties for "Breaking and Entering" than for apparently non-forced entry. Further, forced entry is usually noisy and may result in unwanted attention. Would-be intruders can therefore be expected

to first try passkeys, lock picks or like tests of lock integrity before generating evidence of forcible entry.

[0004] The acts of locking a door behind on leaving and unlocking it upon returning are relatively automatic behaviors, much easier to maintain than additional and often complex arming and disarming sequences required with current home security systems. There is a need, therefore, for a security system that automatically arms upon locking a conventional keyed door and automatically disarms upon unlocking that door. Further, there is a need to reliably detect and alarm upon lockset tampering and similar indicators of attempted illegal entry. These needs would ideally be filled by a device able to operate with existing mechanical locksets and with all alarm operations fully controlled by normal actuations of the existing lockset.

Summary of Invention

[0005] A preferred embodiment of the device for detecting tampering with standard mechanical locksets comprises; a pair of electrical contacts placed within the recess that receives lock's bolt, a ribbon cable with three conductors, and a control box. The contacts provide an electrical connection to the bolt and hence the entire lockset when the bolt is in its extended or locked position. The two con-

tacts are each connected to individual conductors in a ribbon cable that also carries a third conductor, positioned to run vertically along the door frame below the bolt receptacle. The third vertical conductor approaches the other two at approximately the height of the bolt, and then all three make a short horizontal run to a control box secured to the interior door frame or wall.

[0006] The two contacts within the bolt recess operate cooperatively to signal whether the bolt is in its extended and locked position or in its retracted and open position. The active, or energized, of the two contacts also serves to convey a low-level RF signal to the entire lockset including all externally accessible mounting and operational features. When a person standing by the door touches any part of the energized lockset, the capacitance measured between the lockset and the vertical wire is significantly increased.

[0007] Logic circuitry within the control box is used to discriminate between normal operation of the lockset and operations indicative of tampering. Representative tampering detected includes sequentially testing multiple keys, use of lock-picks, and application of disassembly tools.

[0008] The novel features of this invention, as well as the inven-

tion itself, both as to its structure and operation, will be best understood from the accompanying drawings, taken in conjunction with the accompanying description in which similar reference characters refer to similar parts.

Brief Description of Drawings

[0009] FIG. 1 is a perspective view of the automatic lockset tamper detection device in its intended environment.

[0010] FIG. 2 is a perspective view of the bolt contacts and their connection to the ribbon cable.

[0011] FIG. 3 is a schematic diagram of the control box circuitry.

Detailed Description

[0012] Referring now to FIG. 1, there is shown a door with lockset. The door is fitted into door frame *6* to which it is secured by hinges *7*. To lock or unlock the door from the inside, bolt actuator *5* is rotated in one direction so as to extend the bolt and thereby lock the door, or in the opposite direction to retract the bolt and unlock the door. Generally this operation is accomplished by a key on the outside or a rotatable knob on the inside. Adapted to the door and frame are three conductors, *2*, *3*, and *4*, shown as they are positioned within a ribbon cable and against the door frame.

[0013] FIG. 2 shows bolt receptacle *8*, latch plate *9*, and two leaf-spring contacts *11* and *12*. The leaf-spring contacts are secured within the bolt receptacle so as to ensure that they are wiped by the metal bolt as it extends or retracts. The material, position, and shape of these contacts ensures reliable electrical contact with the bolt and provides sufficient deflection so as to not interfere with the bolt's normal motions. The depths to which the contacts are placed within the bolt receptacle ensures that both contacts engage a fully extended bolt, that neither engages a fully retracted bolt and that the intended sequence of contact engagement is maintained.

[0014] Both leaf-springs, the adhesive to secure them in place, the conductors attached to the leaf-springs, and all required insulation comprise an integral ribbon cable assembly *9*. Orientation of the cable assembly is conveniently established by positioning the cable corner between the two contacts to coincide with the corner of the bolt recess as shown in FIG. 2. This orientation allows successful operation irrespective of bolt size. The other end of the ribbon cable connects to the control box by means of a conventional ribbon cable connector.

[0015] FIG. 3 is a schematic of control box circuitry. Ribbon cable

conductors *2*, *3* and *4*, described above,engage with control box circuitry via connector *13*. Conductor *2* is connected to the tank circuit of Clap oscillator *14*, conductor *3* is connected to RF detector circuit *15* and conductor *4* is connected to circuit ground or common *16*. External capacitance, measured between conductor *2* and conductor *4*, is effectively additive to tuning capacitor *17* andserves toincrease tank circuit capacitance. This external capacitance has a small fixed component, attributable to external wiring, and a large variable component, attributable to human contact with the external portions of lockset *5*. Such contact with the closed or locked lockset extends the energized area to include the person touching the lockset and thereby significantly increases the capacitance measured between conductor *2* and conductor*4*. A substantial portion of this capacitance increase is attributable to the relatively large capacitance developed between the person outside the door and the vertical portion of conductor *4* on the interior side of the door frame. The net effect of this increased capacitance is reduction in the frequency of oscillation upon human contact with the lockset whether that contact is direct, through keys, through tools, and/or through gloves.

[0016] Detection of change in oscillation frequency, indicative of human contact is obtained through frequency change detector *18* comprised of phase locked loop (PLL) *19*, monostable multivibrator*20* and D-type flip flop *21*.Phase locked loop*19* is configured tomaintain phase lock with oscillator *14* over frequency changes associated with normal circuit noise, component drift, and environmental changes. Loop filter *22* is configured to control how quickly the phase locked loop can react to changes in the frequency of oscillation of oscillator *14*. Slow changes in oscillation frequency are tracked by means of pulses from the PLL's phase detector, approximately one per oscillator cycle, that continuously provide the feedback required to maintain phase lock between randomly drifting oscillator *14* and the PLL's voltage controlled oscillator (VCO). Positive pulses from the phase detector drive the PLL's VCO toward phase lock through increasing VCO frequency while negative pulses achieve lock by driving the PLL's VCO frequency down.

[0017] Upon a person touching the external lockset, the magnitude of the change in oscillator *14* frequency is too large for the PLL to accommodate with a single short feedback pulse and the output of the PLL's phase detector remains

"saturated" in a low (negative) state for several oscillator periods. A sustained high or low state to the input of monostable multivibrator *20* permits this timer to complete a timing cycle that theretofore was continually restarted before completion, with the edge of each positive going pulse from the PLL's phase detector. Upon full completion of a timing cycle, the NOT Q output of monostable multivibrator *20* provides a positive going pulse to the clock input of D-type flip flop *21*. If the PLL's phase detector output is still low when the monostable multivibrator completes its timing cycle then the Q output of D-type flip flop is clocked from high to low. This negative going transition at the Q output of flip flop *20* reliably signals human contact with the lockset which is further qualified as discussed below.

[0018] To obtain automatic arming or enabling of the alarm, it's necessary to distinguish between contact associated with normally locking the door from contact associated with tampering. This is accomplished as described below: When the lockset is transitioned from its unlocked state to its locked state, the FET output of RF detector circuit *15* makes a transition from low to high. This transition leaves D-type flip flop *23* in its low or cleared state and ensures

that the next positive going pulse at the clock input will, through the connection of the D input to supply, cause the Q output of the flip flop to go high. Because flip flop *23* can only be returned to its cleared state by reopening the lockset's bolt, only a single positive going output pulse is possible after each lockset closure.

[0019] Assuming, then, that the lockset is being locked, the following sequence of events will follow on detection of contact with the lockset as the bolt is engaged. First, D-type flip flop *21*, as discussed above, will transition its Q output from high to low. This in turn will cause the Q output of set-reset (S/R) latch *24* to go high. At the same time, the FET output of RF detector *15* is also high by virtue of the bolt being in the closed or locked position. Both high signals serve as inputs to gate *25*, causing its output to go low and in turn enabling binary counter/oscillator *26* to start. After a short delay of approximately 10 seconds, the eighth stage of counter *25* transitions from low to high and sends a positive going pulse to the clock input of flip flop *23*, causing a positive going transition on its Q output. This positive going transition triggers monostable multivibrator *27*, causing it to produce a timed pulse approximately 1/4 second long which is positive going on

the Q output and negative going on the NOT Q output. The pulse on the Q output serves to "chirp" an audible alarm indicating the system is armed. The pulse on the NOT Q output serves to set flip flop *21* Q output to its high state and S/R flip flop *24* to its reset state and thereby to cause the output of gate *25* to reset and halt counter oscillator *26*. In this condition the system is armed and will announce any tampering detected with an alarm signal commencing approximately ten seconds after any contact not first culminated in successful bolt retraction. This alarm signal will be maintained until either 10 seconds after the lockset is opened and reclosed, or upon automatic shutoff after sufficient time to overflow counter/oscillator *26* and trigger timer *27* on the negative going transition of the final counter stage.

[0020] If the bolt is withdrawn from the bolt recess before completion of the approximately 10 second delay, no alarm will be announced and the alarm system will be disabled by virtue of the low logic signal from the FET output of RF detector *15*. It should be noted that simple removal of the bolt from the bolt recess after the alarm sounds will not reset the alarm unless the bolt is first reinserted and the relatively short time delay is allowed to lapse, This serves

to prevent silencing of the alarm upon destruction of the lockset.

[0021] Signaling lines *28* and *29* provide for connection to cooperative external components to signal respectively whether the lockset tampering detection device is in its alarmed state or not and whether it is in its armed state or not.

[0022] Many modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than specifically described.